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D. L. HOLDEN & BROS.,

MANUFACTURERS OF

ICE MACHINES,

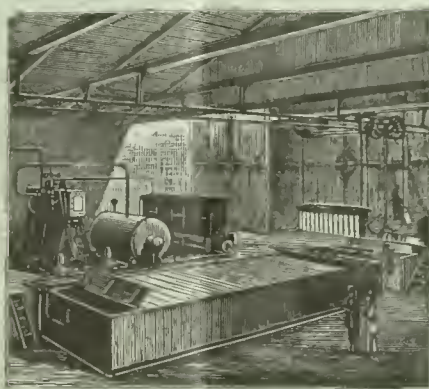
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ALSO

REFRIGERATING MACHINES,

FOR

Breweries, Distilleries, Packeries, Fruit Houses, Steamships, &c.



PENN IRON WORKS,

BEACH AND PALMER STREETS,

P. O. Box, 1808,

PHILADELPHIA, PA. U. S. A.

D. L. HOLDEN,

E. C. HOLDEN,

C. M. HOLDEN.

PHILADELPHIA:
LEHMAN & BOLTON, PRINTERS.
1878.

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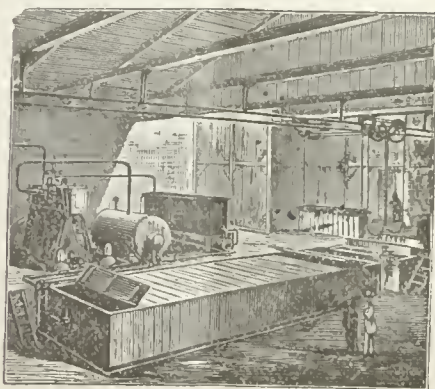
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WITH perhaps some qualification, it has only been within the last quarter of a century, that the inventive mind has thoroughly shown its appreciation and affinity for problems, the solution of which results in good to mankind. Principles of science long ago elucidated, yet apparently neglected and rusted through disuse, have lately led to the development of certain contrivances, the value of which to the civilized community can not be easily overestimated.

It is no new thing to tell, that the evaporation of any volatile liquid produces cold in the liquid itself, which in turn abstracts heat from the vessel containing it, the vessel in turn absorbing heat from its surrounding envelope; or that it would be a new addition to the vocabulary of science, to state, that the compression or expansion of any gas produces heat or cold:—such facts are concomitant with elementary chemical instruction the world over. And yet with principles so long known and which may be traced back through centuries of distance, it is surprising that such facts, subservient as they must necessarily be to the inventive mind, have not led to the earlier development of such means, as would fully utilize their inherent benefits. This is strikingly shown in the means hitherto employed in the artificial production of ice, when from the time of the earliest experimenters upon the principles which underlie this branch of practical science up to the expanded industry of the present day, the efforts made to utilize those principles have been very feeble and disjointed; and it was not until within the last ten years, that the artificial manufacture of ice has ranked among the mechanical industries of the world.

It is not our purpose within the limits of a descriptive catalogue, to enter upon the minute history of the manufacture of ice, much less to detail the causes which led to the development of the present state of the industry, but we shall content ourselves with setting forth a description of those principles of ice making which, in practice, take concrete form in the Holden Ice Machine.

It is scarcely necessary to point out the immense advantages resulting from any successful device to produce cold, and freeze water, independent of the natural operations which in most winter seasons produce a yearly crop of ice in the temperate zones. The harvest and storage of this ice has become an immense branch of industry; but useful and necessary as it is, it is subject to some serious drawbacks which make other devices for cooling and refrigerating highly desirable.



In the first place the harvest is very uncertain, and cannot be depended upon, as there are winters when very little or no ice is produced, while in southern or tropical climes, where it is never produced by nature, it has to be carried from northern regions. This transportation is very objectionable for two reasons: first, the bulkiness and weight of the material, and secondly, the great loss continually occurring by such transportation, which, notwithstanding the utmost precautions, amounts often to 60 or even 70 per cent.

If cooling is required for the preservation of perishable articles of food, such as meat, fish, or fruit, the amount of ice to be carried along while in transportation to effect such cooling, depends of course upon the time occupied in such transportation, and if this time be protracted; as in the case of a voyage to Europe, for instance, the least delay may cause the ice to give out and cause the loss of the whole of the perishable cargo. Of this we have lately had several instances, so that it has been acknowledged that any method of transportation by which ice has to be depended upon for cooling, is, to say the least, a very risky enterprise.

Then there are several industrial enterprises, such as brewing beer, which during the summer season, cannot be carried on except by the liberal use of ice. Before this cooling by ice was introduced, the operations were suspended in summer, which involved great loss, as about half the time the establishments were useless. Thanks to the extension of the ice business, and the possibility to obtain it in large quantities, at any time of the year, from the ice houses, breweries may be kept in operation the whole year round. But the large quantities of ice required in this industry, is a great drawback. In order to realize this, we have only to mention that some breweries consume from 10 to 100 tons of ice per day. It is not only the expense of the ice itself, which is objectionable, but the inconvenience of the daily handling of the bulky material, and also the bulky contrivances necessary, to obtain the benefit of the cooling effect, and if science succeeds in producing by artificial means the same results, it must be considered one of the most generous benefits she can bestow upon a civilized community.

It is well known, that for several years attempts have been made in the United States as well as in Europe to accomplish this, and it has been done with more or less success. Its possibility has long been established, but the only question remaining, is that of expense, and the operation has to be carried on in such a way, as not only to compete with, but to cost less than, the expense involved in the use of natural ice, consisting in its cutting, storing, transportation and handling.

This has now been most successfully accomplished, by the improvements invented, patented and now introduced by Mr. D. L. Holden, of which a description is given below. He is now manufacturing these ice and cooling machines, on a principle which fully secures the great question of economy, and they are in successful operation in several breweries, packeries, &c., giving the utmost satisfaction.

In order to understand the operation of his machine, it may be well to explain the principle, upon which all machines of this class are based. The general principle is, that as heat may be utilized to produce power, of which the steam-engine is an illustration, even so power may be utilized for the abstraction of heat, that is for the production of cold, and as the steam-engine gives a cheap source of power, the only question is about the proper means to effect this conversion.

The evaporation of volatile substances, by the heat absorbed, and apparently disappearing during this evaporation, furnishes the most ready means to produce an artificial refrigeration; but in order not to lose the volatile material, and to use it over and over again, it is enclosed in air-tight vessels, in one or more of which, it is forced to evaporate by means of an exhaust pump, driven by steam or other motive power, while in others it is condensed by the same pump, and restored to its liquid condition; but as the evaporation produces great cold and converts the vessel in which it takes place into real refrigerators, the recondensation produces just as much heat, and raises the temperature of the vessels in which it is condensed, but this heat is easily disposed of by a current of ordinary cold water, after which the liquid is again passed into the refrigerator, and by repeated evaporation, the temperature of the uncongealable liquid is kept down to the desired standard.

This is the general principle of the Holden Machines, and these the various peculiar details which have caused a success, after which many others have been searching in vain.

In order to judge of their success, we will only state that in the brewery of Messrs. Bergner & Engel in Philadelphia, where a machine driven by a 24 horse-power steam-engine was in effective operation for over five (5) months, it was found competent to cool, every hour, 100 barrels of water of 32 gallons each, from 60° to 45°, or from 56° to 44°, or from 50° to 41°, etc., on an average of 12°, sometimes much more, and when desired, in cooling the water to below 32° and freezing the same.

If we put these results at the theoretical value, we are forced to the conclusion, that this machine is more economical than any heretofore constructed. 3200 gallons of water, or nearly 30,000 lb cooled 12°,

is equivalent to the abstraction of 360,000 units of heat per hour. To changing water of 80° into ice of 32° , requires the abstraction of $142+48$, or 190 units of heat; consequently the amount of cooling is equivalent to the formation of $360,000 \div 190$, or 1895 lb of ice. As 24 horse-power requires the consumption of about 100 lb, and with an inferior boiler of 130 lb of coal per hour, we see that the combustion of every pound of coal is able to freeze from 10 lb to 13 lb of ice, or in other words, is equivalent to the cooling effect of from 10 lb to 13 lb of ice.

It is scarcely necessary to point out the enormous advantage of storing one ton of coal, which does not continually melt away like ice, as a substitute to the storage of 10 to 13 tons of ice, which besides, takes up, weight for weight, three times as much room, so that for equal bulk, one ton of ice will take up as much room as an amount of coal, which in its cooling effects, with the help of this machine is equivalent to some 50 tons of ice.

The following are the actual results, produced daily with a 15 ton machine,—real work 16 tons,—in the brewery of Messrs Bergner & Engel, showing saving over old method of using ice:—

16 tons of ice, @ average cost \$4.50 per ton,	-	\$72.00
3 lb coal per horse power, for 24 h. p. 72 lb		
72 lb " per hour, gives per day, 1728 lb		
1728 lb coal @ \$3.00 per ton,	- - -	\$2.60
2 men @ \$2.00 per day,	- - -	\$4.00

Total expense of Machine, \$6.60

6.60

Saving by new method over old, \$65.40

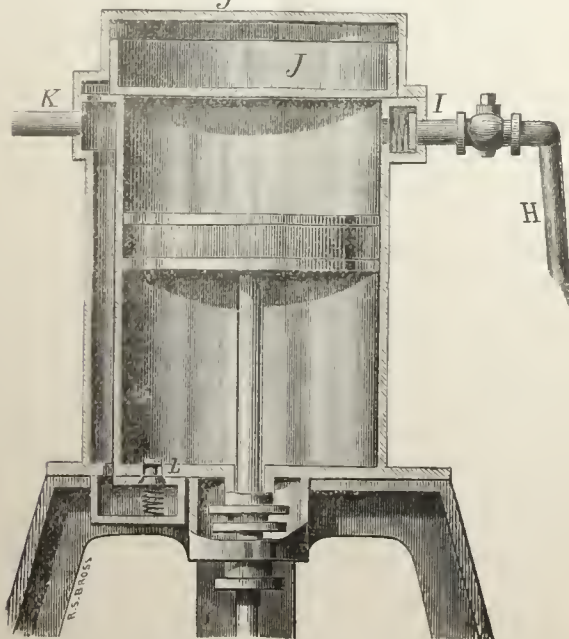
Take the average use of the machine, at 8 months of the		
year and 26 days to the month, shows a saving of		\$13,603.20
Cost of Machine,	- - - - -	12,500.00
Made over first cost in one season,	- - - - -	\$1,103.20

PUMPS.

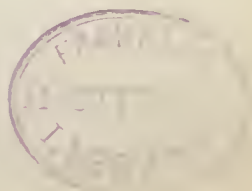
The essential feature of an ice machine is the pump, and upon its perfection depends the economy and success of the machine. It is the defective construction of pumping apparatus, that has consigned so many ice machines to disuse, and it is the opinion of those well versed, that without a perfect pump, an economical ice machine is impossible. It is upon the perfect arrangement of the vapor-pump and valves, aside from the peculiar arrangement of the cooling coil and bath, that the success of our machines is founded. And it may here be stated, that we are the sole owners of the original patents, covering pumps with movable heads, which patents include the original Gottfried patent bearing date May 1st, 1866, and number 54,328, and also those of Mr. D. L. Holden; and as all patents upon pumps with movable heads are tributary to the foregoing, any person infringing upon them will be duly prosecuted.

The vapor pumps are single acting and two in number, one of which is shown in section in Fig. 3.

Fig. 3.



They communicate with pipe H, from the cylinder through inwardly opening check valves, I, located in the branches of the pipe. These pumps are also provided with a gravity cup-shaped valve, J, which is of greater diameter than the piston cylinder, and plays between the cylinder head and the flange of the body of the cylinder, upon which it is seated, being guided in its movement by ribs in the enlarged cavity of the cylinder head. In operation, upon the descent of the piston, the gas is drawn through the pipe, H, the check valves, I, are opened, and the pump cylinder filled. But when the piston rises the check valves are closed, and the compressed gases above the piston lift the valve, J, and allow the gas to pass out into the pipe and from thence to the condenser through K. As however, the gases contained in the portion of the pipe between the pump cylinder and the check are compressed, but not forced out, if the piston should descend with this pressure of gas retained here, it is obvious that the gas would expand, and by partially filling the chamber, prevent the perfect exhaustion of the gas cylinder. To provide for this, the piston in its upward stroke passes the orifice of pipe, H, so that the compressed charge of gas is held in the confined space and is liberated beneath the piston, and upon its descent is driven out through the valve, L, at the bottom into a pipe that communicates with K. It will be observed that the face of the piston, in rising, strikes against the bottom of the cup valve and lifts it, and upon the reverse stroke, the valve seats itself upon the flange of the cylinder, while the plain ground face of the piston departs from the plain ground bottom of the valve, it produces as nearly a perfect vacuum as possible to attain in a pump, there being practically no cushion of gas between the valve and piston. In the construction of the ordinary air pumps, which have heretofore been used in connection with ice producing machinery, there has always been the defect of rigid heads to the pumps, which prevented the perfect exhausting of the pump cylinder, as the piston must necessarily be limited in its travel towards the heads of the pumps to prevent striking. In pumping a liquifiable gas it would be impossible to exhaust this clearance, at the ends of the stroke of its contents. which contents would be free to expand and partially fill the cylinder, upon each alternate reverse stroke of the piston, thus taking so much from the effective duty of the pump. It is here where our pump asserts its superior features. The indicator diagrams obtained in testing this machine, in regard to the pressure in the vacuum cylinder, reveal to the expert a most perfect arrangement of the pumping apparatus.



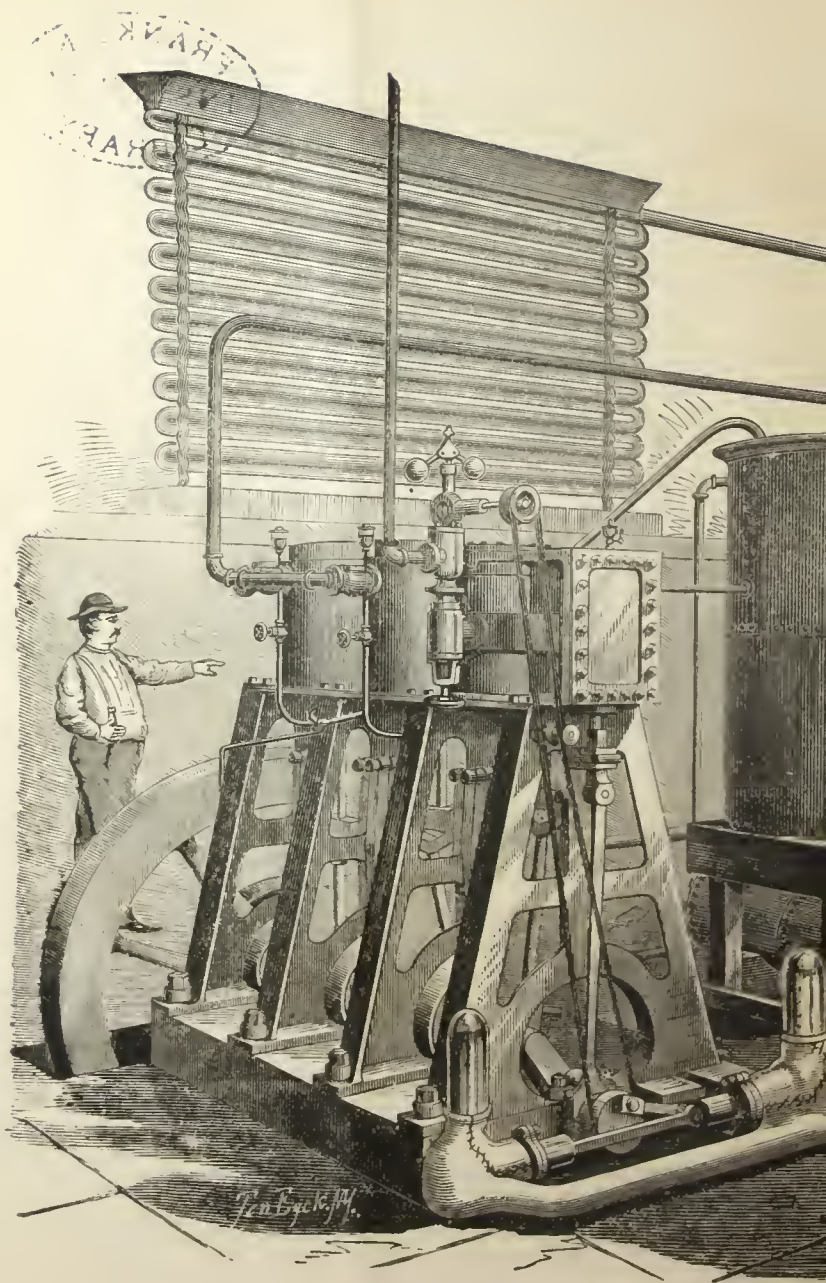
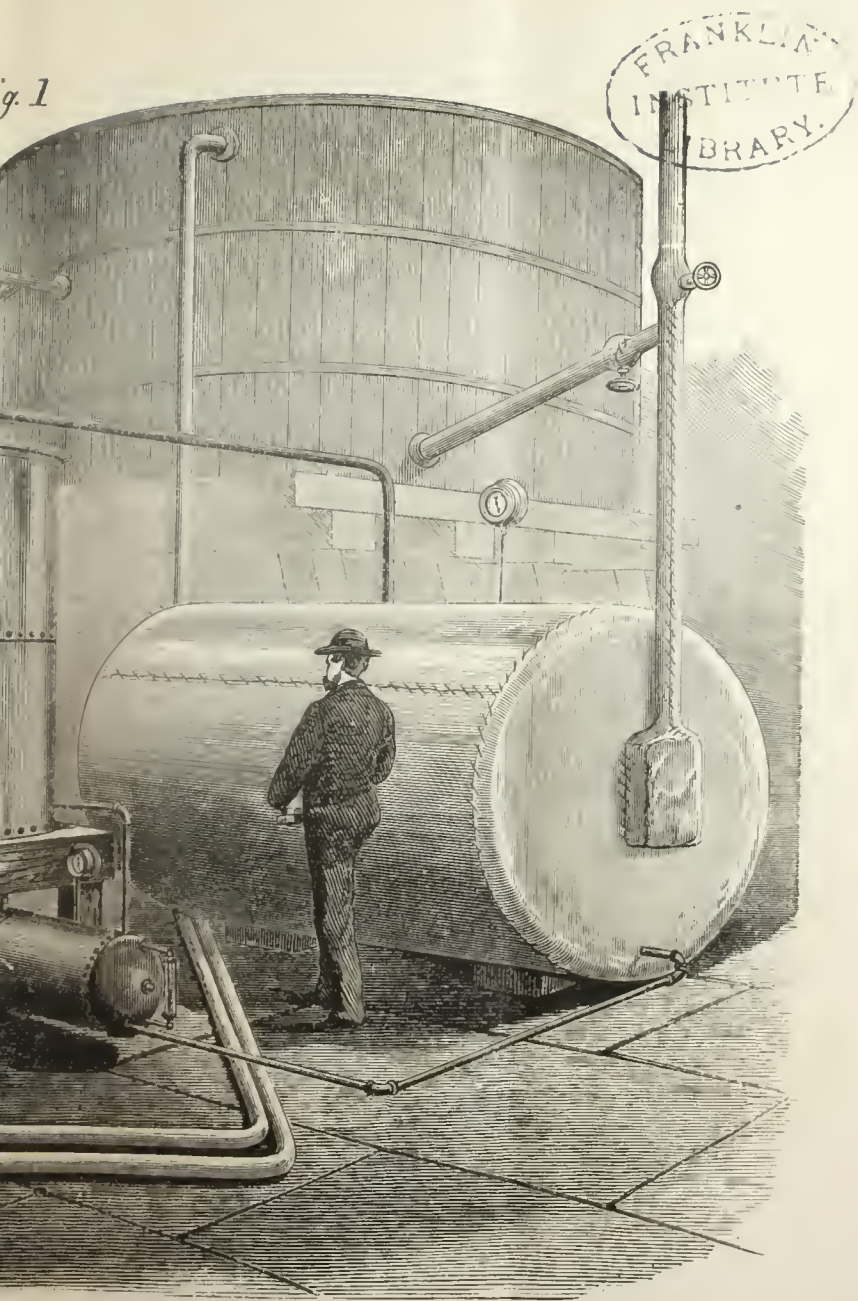


Fig. 1. is a perspective view of the Machine as used in breweries, a de

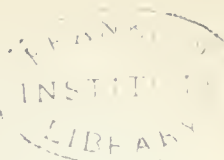
Fig. 1



of which is embodied in the description of Pumps and Refrigerators.



REFRIGERATORS.



Next in importance to having perfect pumping facilities, is the necessity of having suitable apparatus whereby the cooling effect, produced by the vaporization of the volatile liquid used, may be fully utilized. With our Refrigerators we fully meet the conditions imposed by the requirements of economy, producing the very best results, as a glance at the workings of our machines will show. The refrigerating cylinder is shown in section in Fig. 2, and is seen on the right of the large Engraving, Fig. 1. It may be made of any suitable material, while it is covered with felt or some non-conducting material.

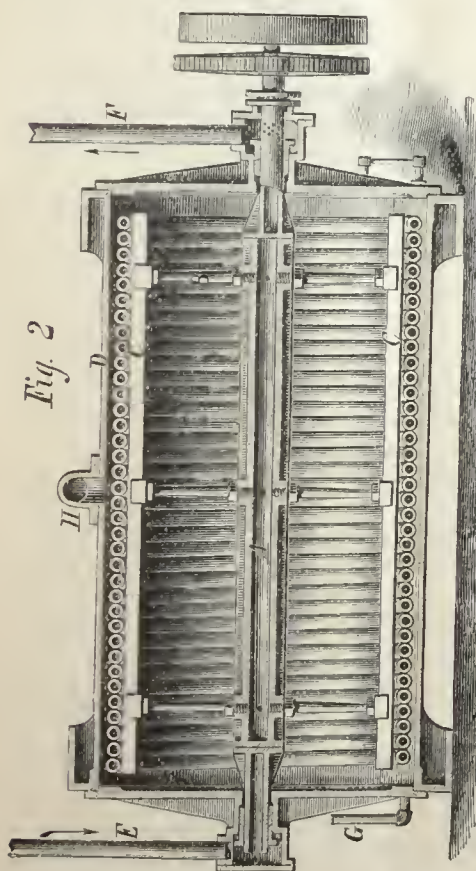


Fig. 2

It is journaled on a longitudinal Shaft, A, which is provided with radial arms, B, which carry upon their outer end longitudinally arranged ribs, C. Around these ribs and near the inner periphery of the cylinder, is wound a continuous coiled pipe, D, in which circulates strongly saturated brine, or other non-congealable liquid, which is received from a convenient cistern or tank. The coil of pipe extends the entire length of the cylinder, and at each end communicates with the hollow ends of the shaft, A, and through this hollow shaft with the supply pipe, E, and the exit pipe, F, so that a continuous circulation of the non-congealable liquid may be kept up in the coil. Inside of this cylinder a volatile liquid

is placed, which may be ether, chymogene, ammonia, anhydrous sulphurous oxide, or any other easily evaporated liquid, which is introduced through a pipe, G, and is maintained at such level as to immerse

the bottom portion of the coil of pipes, which level may be regulated by means of a glass gauge upon the outside. As the coil of pipes is revolved by any suitable mechanism, the coil passes to the upper portion of the cylinder, with its surface moistened by the volatile liquid, which it carries up from adhesive attraction; and as the cylinder is exhausted of its gaseous contents through the pipe, H, by means of the pumps seen at the left of the Cut, Fig. 1, the evaporation of the liquid upon the surface of the coil rapidly takes place to supply the partial vacuum, and a corresponding reduction of the temperature of the pipes, and its contained vehicle of non-congealable liquid takes place.

To guard against leakage, which would prevent the best action of the pump in effecting evaporation, the ends of the shaft, A, are provided with stuffing boxes, while the outer parts of the bearings are enlarged to form water boxes, which are filled with the non-congealable liquid, and these, together with the stuffing boxes, effectually seal the bearings against all leakage of air in the interior.

As the gas is exhausted from the cylinder, it passes to the pumps previously referred to, from thence to a condenser, seen in the center of Fig. 1, and thence through a pipe as liquid, to a receiver which is shown underneath the condenser.

In order to meet the requirements of purchasers, who desire to use either anhydrous sulphurous oxide, or ammonia, we have recently invented and patented, an improved form of Refrigerator especially devised for that purpose.

CONDENSER.

Heretofore, the use of ice machines has necessitated the command of a considerable volume of reasonably cold water, for use on the condenser to restore the gases to the liquid state preparatory to reusing. In order to use the minimum amount of water, in producing the maximum condensation, we have recently invented an improved Condenser, by means of which, the use of one fourth the quantity of water formerly used, will produce the same cooling effect, as with the old form of condensers. The above condenser is covered by patent, bearing date, July 2nd, 1878, and numbered 205,641.

It consists essentially of a cylindrical shell, A, with close fitting heads, F and B. Within the shell is placed a series of U shaped tubes, attached at the one end to a wrought iron tube sheet, fitting between the end of the shell, A, and the head, F, forming a gas tight joint. The legs of the U tubes are separated by a partition or baffle plate, D, the backward

Fig. 2.

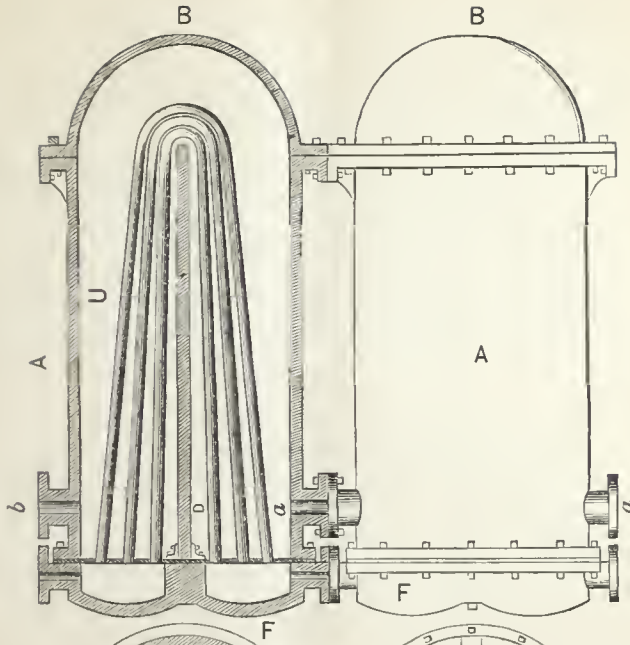
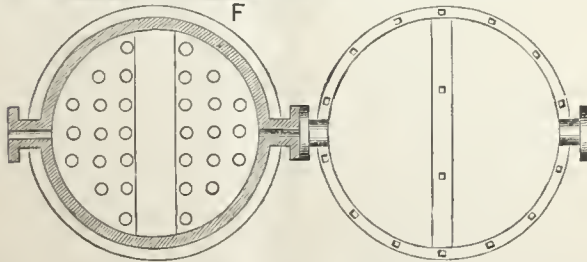


Fig. 1.



extent of which is limited by the curvature of the tubes. The head, F, is a double compartment chamber, the one compartment communicating with the upper ends of the tubes, while the other communicates with the lower ends. The gas or vapor to be condensed, is admitted into the upper compartment, passes through the tubes into the lower compartment, and thence into the next section of the condenser, the water meanwhile circulating through the shell around the baffle plate, D, and through the apertures *a. b.* An increase or decrease of condensing surface is obtained by increasing or decreasing the number of sections.

One great objection with condensers heretofore, has been the inability of cleaning the tubes from sediment. This condenser offers special facilities for cleaning out, while at the same time, it can be made absolutely tight, as the tubes are only attached at one end, and are consequently free to expand longitudinally.

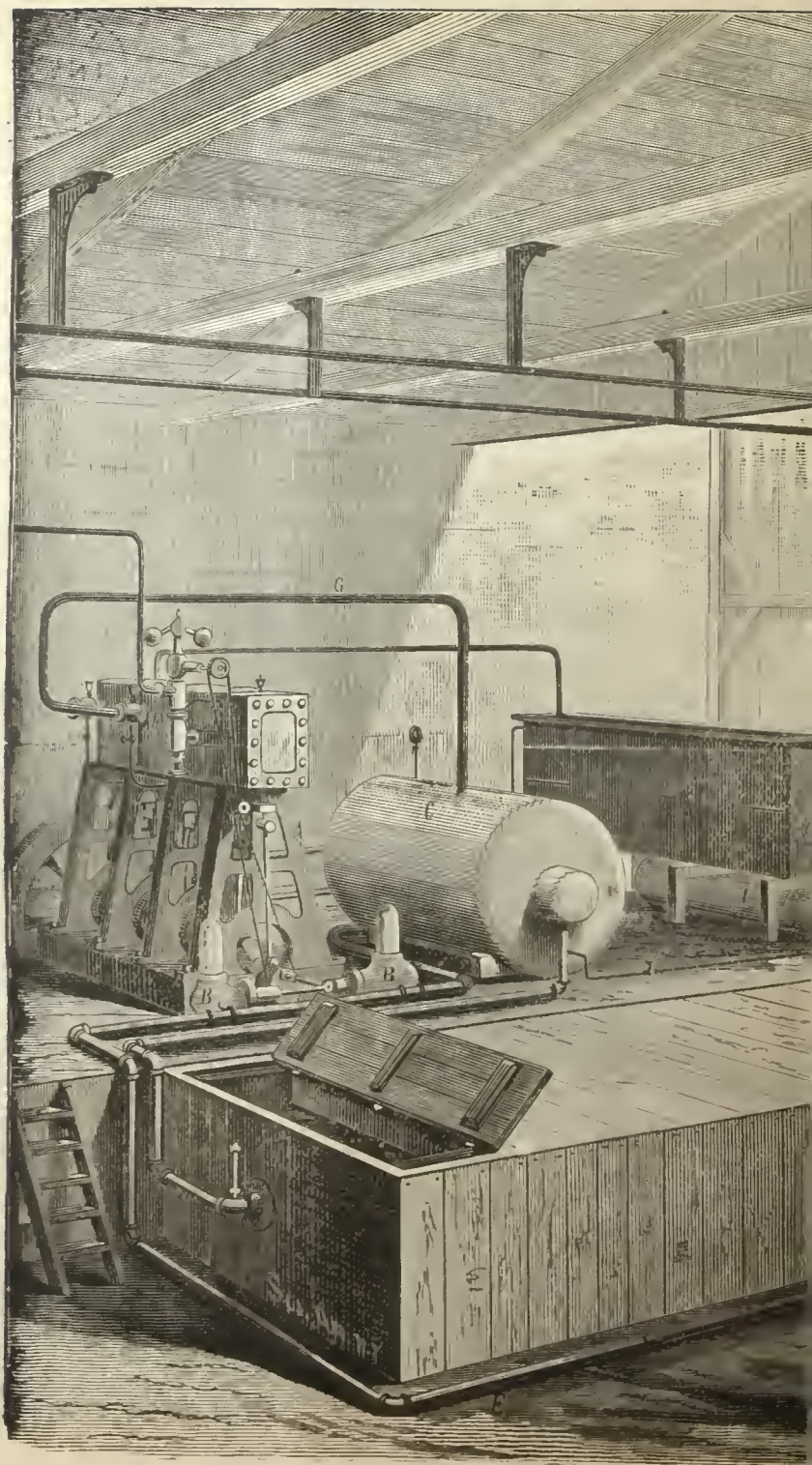
(From the "Scientific American," of March 16, 1878.)

THE HOLDEN ICE MACHINE.

"In our Issue of August 18, 1877, we illustrated and described in detail the above named invention, showing its application to refrigerating purposes in breweries. The machine has recently been adapted to ice making, and has achieved, we are informed, very notable success. In using it for this purpose the manufacturers have added some valuable improvements which have materially increased its efficiency, and to these, more especially, it is our object now to direct the reader's attention.

"The machine is adapted to the use of any volatile liquid, such as common ether, mythylic ether, chymogene, sulphurous oxide, etc., the vapor of which is used to lower the temperature of a non-congealable liquid, and this last freezes the water contained in suitable vessels and immersed in it. The action of the apparatus, as shown on the left of Fig. 1, is briefly as follows: A is the engine; B B are circulating pumps, which force the non-congealable liquid through a rotating coil in the cylinder, C, thence into the freezing tank, D. From the further extremities of the latter the liquid is conducted by the pipe, E, back to the pumps, and so passes again to the cylinder. At the bottom of the cylinder the ether or chymogene is placed so that the coil through which the water passes, as it revolves, dips in the volatile material, and the thin film of this which remains on the core is rapidly evaporated through the action of the pumps, F, which communicate with the cylinder by the pipe, G. In this way the temperature of the non-congealable liquid passing through the tubes is lowered. The vapor carried off by the pumps is by them driven into the condenser, H, and here it is cooled by water, liquified and collected in the reservoir, I, whence it once more passes to the bottom of the cylinder, C. It will be noticed that there are two circulations, one of the non-congealable liquid, through cylinder, C, pumps, B, and tank, D, and another of the volatile material, or its vapor, through Cylinder, C, pumps, F, condenser, H, and reservoir, I.

"The new portions of the apparatus can now be clearly understood; and these are found in the tank, D, and its appurtenances. The water to be cooled is placed in deep cans, thirteen of which are set in a carrier, as shown in Fig. 2. When the cans are immersed in the tank, this carrier extends across the same, and the rollers at its extremities rest on ways made on the sides, as shown in the transverse section



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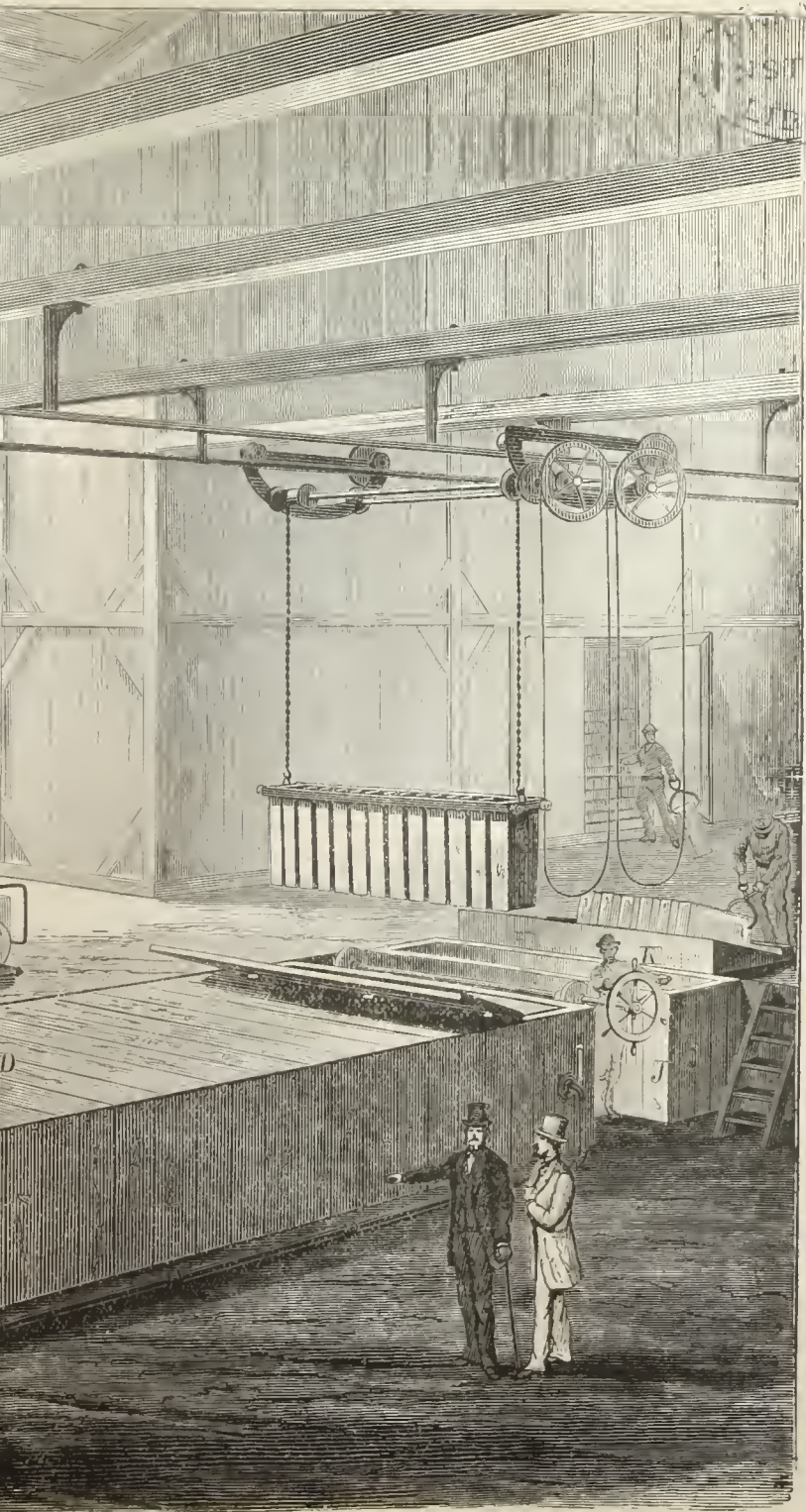




Fig. 3. The tank is capable of holding twenty-six of these carriers placed side by side. That is, this number would be inserted at the beginning of operations.

Fig. 2

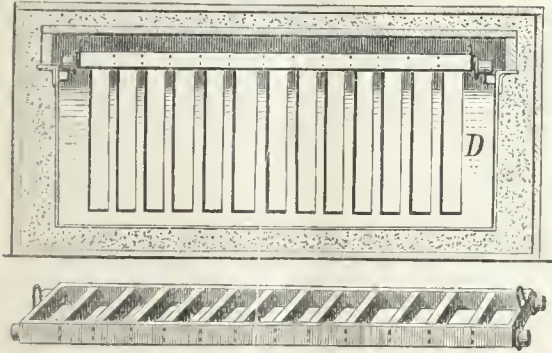
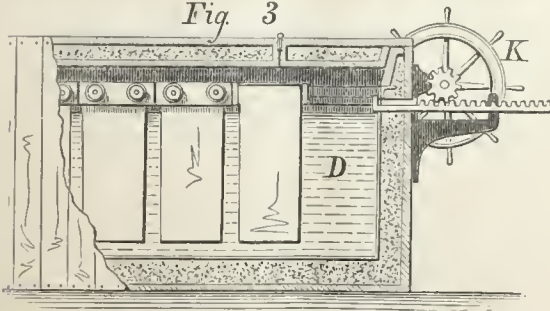


Fig. 3



“Above the tank is a travelling crane, which is used for lifting the carriers with their cans out of or into the freezing liquid. Obviously the latter is coldest at its point of entry, and therefore the ice is removed by the crane from that extremity, and transported over the tank to a bath at J, into which the cans are dipped for a moment to loosen their contents, and the ice is then turned out on an inclined plane.

“Meanwhile the attendant revolves the wheel, K, which, by a pinion, operates a rack which pushes the carriers bodily to the further end of the tank, so as to close up the space left by the carrier removed, and to afford a place on the right for the insertion of the same carrier, the cans of which are at once refilled with water. The crane then moves forward again and takes out the endmost carrier, and thus the operation

continues, carriers newly filled being inserted at one extremity, while those the contents of the cans of which are frozen are removed from the other.

“The economy of this arrangement will be obvious when the varying temperature of the liquid in the tank is remembered. The newly filled cans enter liquid of a temperature of, say, 32° , a film of ice at once forms, and as they gradually move forward they are subjected to greater degrees of cold as the ice film thickens, until finally they reach the coldest point, when the warmth of the remaining uncongealed water has to be extracted through the greatest thickness of ice. The cold, to use a very unphilosophical but convenient term, is thus economized to the extent, that instead of the entire contents of the tank being reduced to, say, zero, the temperature of only a portion of the same is thus lowered, with equally as good results.

“The manufacturers have recently constructed one of these machines for the Virginia and Gold Hill Water Company, of Virginia City, Nevada. From the report of the superintendant submitted, we learn that, although the contract requirement was 15 tons of ice in 24 hours on actual trial, the results exceeded 20 tons, with indications that even this yield could be surpassed, the apparatus working at only two-thirds of its capacity. For brewers' purposes the Holden machine is already favorably known through its successful use in the brewery of Messrs. Bergner & Engel, in Philadelphia.

“For further particulars address the manufacturers, Messrs. D. L. Holden & Bros., Penn Iron Works, corner Beach and Palmer Sts., or P. O. Box 1808, Philadelphia, Pa.”

MACHINES FOR FAMILY USE.

We have been in receipt of numerous inquiries, relative to small sized machines for family use, in localities, where the population is too small to warrant the use of large machines,—such machines to be operated by hand or light motive power. We have lately turned our attention to the development of such means, whereby this result may be accomplished, and are now experimenting upon small sized machines, with capacities varying from 5 to 8 lbs. per 2 hours, in which it is intended to use no volatile liquid. We hope to have a machine of this description in successful operation in a short time.

METHODS OF FREEZING.

The purpose for which ice is used generally, governs the size and form in which it is manufactured. We construct our apparatus to freeze in either one of two ways: freezing in cans, or freezing upon large surfaces. Our method of freezing in cans, is the best that has ever been devised, both as regards convenience and effectiveness, for with it a minimum amount of labor, can perform the manual manipulations necessitated by the use of our largest machines. By this method, if the ice is frozen rapidly, it is slightly opaque, for reasons set forth under the head of transparency, but which can be obviated by the use of distilled water, or by slower freezing and a larger number of cans. The arrangement is such, that one carrier loaded with cans is being discharged of its frozen contents, while another filled with fresh water is being introduced into the freezing box, thus making the freezing a continuous operation. (See cut of Virginia City Machine.) Where the ice producing capacity of the Machine is much in excess of the daily consumption of ice, and it is desired to run the Machine to its full capacity, this method of freezing, affords great facilities for successfully storing the surplus ice, owing to the convenient size in which the ice is frozen.

In our method of surface freezing, the ice is formed upon large metallic surfaces, the size of which depends upon the purpose for which the ice is used, but is usually of the following dimensions:—7 feet long, 3 feet wide, and from 8 to 12 inches thick.

TRANSPARENCY.

It is not only the purpose of an ice machine, to enter into economical competition with Nature in regard to the quantity of ice produced, but also to occupy no subordinate position in reference to the *quality* of the product. The transparency of ice depends upon the rapidity of

freezing, and is always an element of the same. Slow freezing invariably produces clear, transparent ice, too rapid freezing, the reverse,—that is, the ice is partially clouded or opaque, due to the imprisonment of small bubbles of air which the rapid freezing prevents from escaping at the surface of the water. The cost of production of either opaque or of transparent ice is the same, the clear ice simply necessitating a larger freezing surface. It will thus be seen that the *quality* of the ice is at the will of the purchaser of the machine. With our machines we manufacture ice of any form or size, to conform with the requirements of purchasers; but as we build our freezing apparatus with reference to standard sizes, we do not deviate therefrom, except at the special request of the purchaser, which must be made at the time of ordering the machine.

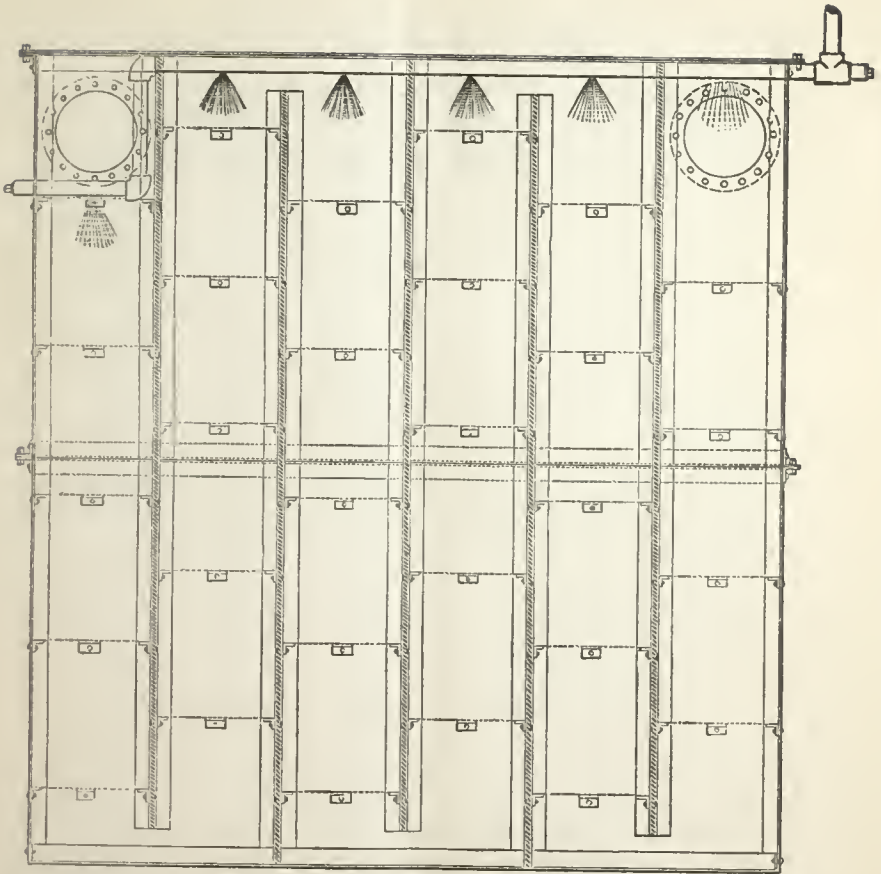
METHODS OF REFRIGERATION.

The cooling of liquids, such as beer for instance, may be effected either by pumping the beer directly through the machine, instead of the non-congealable liquid, or by passing the non-congealable liquid through a series or coil of pipes, and allowing the beer to trickle down over them, the non-congealable liquid passing in continuous circuit back to the machine where it is again refrigerated.

The cooling of rooms or beer vaults, may be effected either by circulating the non-congealable liquid through a series of pipes around the room, or by bringing the air directly into contact with the non-congealable liquid.

In the former process, if any moisture be in the air (which there always is) it collects upon the pipes, and, were it not prevented, would freeze upon them, forming a non-conducting jacket of ice, which in time would become so thick, that the refrigerative effect of the non-congealable liquid would become almost entirely lost. With our system of cooling and dehydrating air, this freezing is prevented by allowing salt water, glycerine, or any non-congealable liquid to trickle upon the pipes, thus giving the full refrigerative effect of the cooling liquid to the air which comes into direct contact with the pipes. The above process is covered by the patent of Sam'l B. Lount, which bears date March 28, 1876, and numbered 175,291. We are the exclusive owners of this patent.

In our direct process of cooling air, the air is forced or exhausted through a "cooling box," which is rectangular in form, and consists essentially of a number of "baffle plates" or vertical partitions, which are somewhat shorter than the height of the box and are attached



alternately to the top and bottom of the box, thus leaving alternating apertures at the top and bottom. Between these partitions are placed horizontal screens at a distance of about two feet apart; while longitudinally through the top of the box runs the pipe containing the non-congealable liquid. The bottom of this pipe is perforated with a number of small holes through which the non-congealable liquid is sprayed. This spray comes into contact with the air circulating around the "baffle plates," and not only cools the air, but likewise dehydrates it, that is, deprives it of all the moisture it can contain above that which exists in the air at the temperature of the cooling liquid.

SPACE REQUIRED.

The space required to accommodate the ice producing machinery varies with the size of machine, and also with the purpose for which the machinery is intended, whether for ice making or simply refrigeration. Where buildings already exist, in which it is desired to place our machinery, we arrange the apparatus to conform to the requirements of the buildings; but where special buildings are erected for the purpose, it is best to construct them to accommodate the machinery, and when so desired, we will furnish all necessary information in regard to their construction with plans if necessary. The box in which the ice is produced, should be as thoroughly insulated as possible from the influence of the external atmosphere, which of course necessitates the use of the best non-conducting materials in the construction of its walls, for which purpose, as embodying cheapness, may be mentioned framed or hollow walls of wood, the empty space between the clap-boarding being filled with dry saw-dust. Properly used these materials answer a very good purpose. Where the machine produces ice in excess of the daily consumption, and it is desired to store the surplus, an apartment or house is necessary, which should be similar in construction to the above described box.

REFRIGERATING AGENTS.

Nearly every volatile liquid may be used as a refrigerating agent,—the use of any necessitating the construction of special machinery whereby its cooling properties may be fully utilized. The conditions imposed by the use of many volatile liquids exclude them from general use. The number of available substances is therefore limited, in which may be classed as principal, Chymogene, Ammonia, and Anhydrous Sulphurous Oxide.

Chymogene is a light hydro-carbon, a waste product of the distillation of petroleum, the boiling point of which usually ranges from 10° to 40° Fahrenheit, but which may be varied at will, by a slight modification in the mode of preparation. The vapor of Chymogene is extremely heavy, being eight times greater than that of water, and when we consider these facts along with the amount of latent heat its evaporation absorbs, we are forced to the conclusion that Chymogene is the most advantageous substance known, for use, in the production of artificial ice. Considering, that ice machines have only to do with the volume or bulk of the vapor of the refrigerating agent, regardless of its specific gravity, that is, as each stroke of the vapor pump displaces a

certain volume of vapor, be it heavy or light, and as the refrigerative effect for equal volumes of different gases or vapors may be measured by the product of the latent heat, multiplied by the specific gravity, it is apparent that the heavier the vapor, the greater will be the amount of matter displaced at each stroke of the pump, and consequently, in the case of chymogene, an amount of latent heat is absorbed by its evaporation far in excess of any other known substance.

Chymogene does not, under *any* circumstances, injure the metals, has no affinity for air, water, or oils, and is in itself a lubricant. It is inflammable as are nearly all gases, and when mixed with air in the proper proportions, is explosive; but as this latter will only take place by means of mechanical admixture, as in the case of a laboratory experiment, it is apparent that any skepticism in regard to its use, is only inherent with those who envy its success as a refrigerative agent.

In relation to the explosive nature of chymogene, it is pertinent here to say, that through ignorance or negligence on the part of the person in charge of one of our machines at Hannibal, Mo., a check valve was detached from the machine, while the main valve in the pipe leading from the machine to the condenser had been left open, which pipe was filled with the vapor of chymogene under pressure of 45 lbs. As a consequence the vapor escaped into the building, filling the same, and finally found its way to the boiler room, where coming into contact with the fire, ignited and burned the building down over the machine, the vapor finally burning at the opening of the pipe from which it was discharged, while some *sixty* gallons of chymogene remained in the refrigerator undisturbed, although it was the source of the inflammable vapor. The damage to the machine was very slight, being mainly involved in the disarrangement of pipe fittings.

We submit this as a crucial test of the non-explosive nature of chymogene, and a positive refutation of the malicious libels that have found circulation at the hands of envious but feeble competitors in our line of business, whose pseudo-success is in the main founded upon misrepresentation.

In order to meet the dishonest criticisms of interested parties with reference to some of the properties of chymogene, we submit the following letter of Prof. Lyman of New York:—

New York, Feb. 19th, 1878.

D. L. HOLDEN & BROS.,

Dear Sirs:

Yours of yesterday recd. The first time I ever saw, or heard, or thought of the idea that "Chymogene acts on greases and oils in a similar way to ether," &c, as quoted by you, was, when a few days ago, I read it in the new pamphlet of the Pictet Ice Co. of 1878, to which you refer.

It then surprised me very much, and now I am still more surprised on being informed that I am quoted as authority for that statement. I shall certainly want other authority before I believe it.

It is true that at the request of friends in Boston and this city, who, I was told were talking of buying a Pictet Ice Machine to take the place of one in Fulton that had given out, I called to see it and reported on it, advising them not to purchase it. I never knew what the trouble was with the one in Fulton, but supposed it was because they had no mechanic employed who properly understood it, to keep it in order; and the fact that they then had no machinery for repairing short of Galveston or N. Orleans.

Hastily, Yours Truly,

A. S. LYMAN, 212 2nd Ave.

The machine above referred to has been in successful operation for over five years, during which time has only once been subject to repairs, which were of a very trivial nature.

Ammonia. For purposes of refrigeration, Ammonia may be used in any one of three states: in the form of Aqua Ammonia, as anhydrous gas, or as highly concentrated solution.

The use of Aqua Ammonia involves the command of a large and constant supply of cold water, not only for condensing the ammoniacal gas, but also to reduce the temperature of the "poor liquor" from which the gas was obtained, to such a degree, that it will reabsorb the gas preparatory to being again introduced into the retort for the purpose of revivification. But as ice machines are not required in climates where the temperature of the water is very low, this objection aside from the question of economy, would exclude their use in countries of torrid or even mild temperatures.

The results obtained from the use of either highly concentrated Ammoniacal liquor, or of the Anhydrous gas, have been very satisfactory in the production of artificial cold.

The mechanical means necessary to manipulate this gas, must be the most perfect, as the attendant high pressure and the penetrating nature of the gas, forbid the use of abortive apparatus. The materials used in the construction of the machine are limited to cast iron, wrought iron, and steel, all of which must be of very superior quality. Copper and brass are not available, as the great affinity of the gas for them rapidly disintegrates them. The facilities at our command render it possible to furnish the best of materials along with the best of workmanship, which, together with the superior features of the machinery, remove all obstacles in the way of fully utilizing the refrigerative properties of either the concentrated solution of ammonia, or the anhydrous gas.

Sulphurous Oxide. In the dry, anhydrous state, Sulphurous Oxide may be utilized by proper apparatus for the production of artificial cold. It has a decided tendency to take up or absorb moisture and form sulphurous acid, and in that state, has strong acid properties and readily attacks the metals with which it comes into contact. Sulphurous acid, in the presence of more moisture, shows a marked tendency to pass into the state of Sulphuric acid, the most powerful of the sulphur acids. This affinity of the sulphurous anhydride for water or moisture necessitates the use of apparatus which will exclude all contact between the oxide and the external air. With our machine we are fully prepared to meet the conditions imposed by its use. We may here state that Mr. D. L. HOLDEN has himself experimented with the oxide, some eight years ago, with reference to its use for the manufacture of ice, and is thoroughly familiar with all its properties, and is confident of furnishing apparatus which will more effectually utilize those properties than any other means in existence.

As certain interested parties claim the exclusive right to the use of Anhydrous Sulphurous oxide for the manufacture of ice, it is proper here to say that the use of the oxide for refrigerative purposes has long been known, and has been embodied in all text books on Chemistry from early times. As there is no valid patent in this country covering the exclusive right to its use, we will meet all the requirements of purchasers who desire to use the oxide, and will fully protect them in that use.

We will furnish the oxide at the rate of 40 cts. per lb.



In this machine any volatile liquid can be used as before mentioned, and the operator has the choice to take that which suits him best under the circumstances. In order to give an idea of the field open in this direction, we insert a table of substances which may be used for refrigeration, and which was compiled from the most reliable authorities, and some new data determined by P. H. Vander Weyde, M. D., of New York, who has also largely experimented in this field, and for many years, has been as well on theoretical as on experimental grounds, convinced of the final success of refrigeration by artificial means.

Name of Substance.	Boiling Point at Atmo- spheric Pressure in deg. Fah't.	Pressure of Vapor, in pounds per square inch, at 65 deg. Fah't.	Spec. Gravity of Liquid at 40 deg. Water=1.	Spec. Gravity of Vapor at 40 deg. Air=1.	Latent Heat of Vapor by equal weight.	Relative Latent Heat by equal bulk of vapor.	Names of Invent- ors who used some of these substances.
1—Turpentine . . .	311	0.9	0.86	4.6	133	611	
2—Water . . .	212	0.3 lbs.	1	0.45	990	447	Leslie, England.
3—Comm. Alco- hol. . . .	173	0.8	0.80	1.26	385	485	
4—Chloroform . .	140	4.0	1.48	4.1			
5—Methyl Alco- hol. . . .	118	0.6	0.814	1.1	390	430	
6—Bisulp. Carbon	112	2.5	1.27	2.6	210	550	Paersh, New Orleans
7—Comm. Ether	90	8.0	0.736	2.28	162	369	Siebe, England.
8—Chymogene	30 to 50	12 to 17	0.6	3.9	170	663	Vander Weyde, N. Y.
9—Sulphurous Oxide . . .	14	60	1.49	2.25	170		Tait, N. Y.
10—Cyanogen . .	— 4	80	0.86	1.8			
11—Mythilic Ether . . .	— 6	90		1.617	240	384	Tellier, France.
12—Ammonia . .	—30	120	0.76	0.59	900	511	Carré, France.
13—Chlorin . .	—35	150	1.3	2.47			
14—Sulph. Hy- drogen . . .	—80	250	1.33	1.19			
15—Hydr. Chl. Acid. . . .	—100	450	0.80	1.26			
16—Carbon. Acid.	—112	600		1.53	300	495	Lowe, N. Y.
17—Nitrous Oxid.	—130	700		1.52	342	520	Vander Weyde, N. Y.*
18—Air	15,000 lbs. pressure per square inch does not liquify it.						Kirk, England.

* Applied for Patent, 1864, but withdrawn and abandoned.

It is seen from this table that the liquids No. 1-6 have rather high boiling points, involving little cooling effect, while 15-17 have very low boiling points, involving strong cooling, but on the other side requiring immense pressure to condense them, hence all attempts to

use these substances for the purpose of refrigerating and making ice have practically been failures. If now we consider that Nos. 13, 14, and 15, have such strong chemical affinities for metals that they soon destroy the apparatus, it is seen that Nos. 7-12 are left, and with each of these more or less success has been obtained—the success depending more on the perfection of the machine used, than on the substance itself.

In this respect the machine here described has great advantages over all others, and we confidently recommend it to all interested, knowing by practical experience that it accomplishes all we claim for it.

The Advantages of our Machines are

Simplicity,—Not more liable to get out of order than the ordinary steam engine. Easily managed; an ordinary mechanic can successfully operate them.

Compactness,—They can be placed in very small space. They produce ice at a much less cost than has ever before been done, besides are equally economical in the production of cold *dry* air for *all* purposes, as breweries, packeries, distilleries, buildings, &c., and for the preservation of perishable articles, in fact for *all* uses where artificial cold is necessary, in any climate.

We find it impossible to give a list of prices, but will give them by letter when the amount of ice to be made, or replaced is given us. Please state locality the machine is to be used in.

Any further information will be promptly given in person or by letter.

All machines sold under a full guarantee for economical production of ice, cold air, &c., also for strength, durability, etc.

TESTIMONIALS.

From a number of flattering testimonials we submit the following:—

Meriam Packing Company.

Fulton, February, 18, 1876.

MR. D. L. HOLDEN,
Fulton, Texas.

DEAR SIR:—In reply to your inquiries in regard to the working of your improved Refrigerating Apparatus and Method of Curing Beef, we would state that the machine works to our entire satisfaction, and accomplishes all you claimed for it, it having been running without loss of time since it commenced—the meat that it has taken care of has been well and thoroughly cured, and the loss has been comparatively nothing. We can recommend it to parties who may wish to try a machine for refrigerating pickle and curing beef as an economical and successful machine.

We are, respectfully,

J. N. MERIAM,

Pres. Meriam Packing Co.

N. B.—The above machine has been in successful operation for over five years.

Bergner & Engel, Brewers.

Philadelphia, July 23d, 1877.

D. L. HOLDEN, Esq.

Philadelphia.

DEAR SIR:—In answer to your request, we hereby gladly certify that the Ice Machine erected by you in our establishment has been accepted by us upon thorough trial, and answers our purpose and expectations in the most satisfactory manner.

We acknowledge with all the more pleasure your success and this happy solution of an important industrial and social problem, since we have had ample opportunity to convince ourselves that the apparatus not only performs that which you promised, but largely exceeds the stipulated capacity.

Our contract required 560 barrels of water to be cooled from 60° F. to 38° F. in 24 hours, which is equal to the production of 8½ tons of ice from water at 80° F., while the actual yield of this machine consists in the cooling of 1,010 barrels of water as above, equal to a production of 16 tons of ice per diem.

For this yield the machine requires an average of 24 horse-power—its construction is so simple and compact and the operation so regular that one man can easily attend it.

We shall at all times be glad to give our colleagues in the brewing trade, and others interested in this subject, every opportunity to see the machine in operation.

Wishing you every success in your valuable invention, which we feel certain must commend itself as a great acquisition to brewers and to all other large consumers of ice,

We remain yours respectfully,

BERGNER & ENGEL.

Office of The Virginia & Gold Hill Water Company.

Virginia, Neva. Jan. 12th, 1878.

D. L. HOLDEN, Esq.

DEAR SIR:—In answer to your request we hereby gladly certify that the Ice Machine erected by you for us has been accepted after trial, and answers our purpose and expectations in the most satisfactory manner.

Our contract required fifteen tons of ice in every 24 hours, while the result on actual trial exceeded forty-thousand pounds, and we are satisfied that it should produce a much larger quantity, if worked to its full capacity, which we do not require.

In our estimation the operation of the machine is perfect, and we believe it to be as lasting as an ordinary steam-engine.

Yours very respectfully,

J. B. OVERTON,

Supt. V. & G. H. Water Co.

With reference to the above machine we have permission to refer to John W. Mackey, Esq. and James G. Fair, Esq., Virginia City, Nevada, and Messrs. Flood and O'Brian, San Francisco, Cal.

Fig. 3.

